Electronic Version
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Claims

[c1] 1. A method of improving transient noise of a switching DC-to-DC converter including a plurality of power supply channels connected in parallel between a DC voltage source and ground for converting the DC voltage source into a plurality of DC output voltages which are separate from each other, the method comprising:
generating a first oscillating signal having a first period, in which during each period of the first period the first oscillating signal presents a peak, a valley, a rising portion gradually increasing from the valley toward the peak, and a falling portion gradually decreasing from the peak toward the valley;
inputting the first oscillating signal to a first power supply channel of the plurality of power supply channels such that at least one switching transition of the first power supply channel occurs during one selected from a group consisting of the rising portion and the falling portion;
generating a second oscillating signal having a second period, in which during each period of the second period the second oscillating signal presents an instantly transiting edge which simultaneously occurs with one se-

lected from a group consisting of the peak and the valley; and

inputting the second oscillating signal to a second power supply channel of the plurality of power supply channels such that at least one switching transition of the second power supply channel simultaneously occurs with the instantly transiting edge, whereby:

the at least one switching transition of the first power supply channel occurs separately in a time domain from the at least one switching transition of the second power supply channel.

[c2] 2. The method according to claim 1, wherein:

the first power supply channel adopts voltage mode feedback control, and

the second power supply channel adopts current mode feedback control.

[c3] 3. The method according to claim 1, wherein the first period is equal to the second period.

[c4] 4. The method according to claim 1, wherein the rising portion of the first oscillating signal is linearly increasing.

[c5] 5. The method according to claim 1, wherein the falling portion of the first oscillating signal is linearly decreas-

ing.

[c6] 6. The method according to claim 1, wherein the first oscillating signal is a triangular wave signal.

[c7] 7.The method according to claim 1, wherein:
the second oscillating signal is a pulse wave signal which presents a rising edge, a pulse width, and a falling edge during each period of the second period, and
the instantly transiting edge of the second oscillating signal refers to the rising edge thereof.

[c8] 8.The method according to claim 1, further comprising:
generating a first auxiliary signal, which is a ramp wave signal presenting a rising portion and a falling edge such that the falling edge thereof simultaneously occurs with the instantly transiting edge of the second oscillating signal, and
inputting the first auxiliary signal to the second power supply channel.

[c9] 9.The method according to claim 8, further comprising:
performing slop compensation of current mode feedback control for the second power supply channel by using the first auxiliary signal after the step of inputting the first auxiliary signal to the second power supply channel.

[c10] 10.The method according to claim 1, further comprising:

generating a third oscillating signal having a third period, in which during each period of the third period the third oscillating signal presents a peak, a valley, a rising portion gradually increasing from the valley toward the peak, and a falling portion gradually decreasing from the peak toward the valley, such that the peak of the third oscillating signal simultaneously occurs with the valley of the first oscillating signal while the valley of the third oscillating signal simultaneously occurs with the peak of the first oscillating signal, and

inputting the third oscillating signal to a third power supply channel of the plurality of power supply channels such that at least one switching transition of the third power supply channel occurs during one selected from a group consisting of the rising portion and the falling portion of the third oscillating signal, whereby:

the at least one switching transition of the third power supply channel occurs separately in a time domain from the at least one switching transition of the first power supply channel and the at least one switching transition of the second power supply channel.

[c11] 11.The method according to claim 10, wherein the step of generating the third oscillating signal is implemented by inverting the first oscillating signal.

[c12] 12.The method according to claim 10, further comprising:

generating a fourth oscillating signal having a fourth period, in which during each period of the fourth period the fourth oscillating signal presents an instantly transiting edge which simultaneously occurs with one selected from a group consisting of the peak and the valley of the first oscillating signal, and the instantly transiting edge of the fourth oscillating signal occurs after a predetermined delay with respect to the instantly transiting edge of the second oscillating signal, and

inputting the fourth oscillating signal to a fourth power supply channel of the plurality of power supply channels such that at least one switching transition of the fourth power supply channel simultaneously occurs with the instantly transiting edge of the fourth oscillating signal, whereby:

the at least one switching transition of the fourth power supply channel occurs separately in a time domain from the at least one switching transition of the first power supply channel, the at least one switching transition of the second power supply channel, and the at least one switching transition of the third power supply channel.

[c13] 13.The method according to claim 12, wherein the predetermined delay is a half of the second period.

[c14] 14.The method according to claim 1, further comprising:
generating a fourth oscillating signal having a fourth period, in which during each period of the fourth period the fourth oscillating signal presents an instantly transiting edge which simultaneously occurs with one selected from a group consisting of the peak and the valley of the first oscillating signal, and the instantly transiting edge of the fourth oscillating signal occurs after a predetermined delay with respect to the instantly transiting edge of the second oscillating signal, and
inputting the fourth oscillating signal to a fourth power supply channel of the plurality of power supply channels such that at least one switching transition of the fourth power supply channel simultaneously occurs with the instantly transiting edge of the fourth oscillating signal, whereby:
the at least one switching transition of the fourth power supply channel occurs separately in a time domain from the at least one switching transition of the first power supply channel and the at least one switching transition of the second power supply channel.

[c15] 15.The method according to claim 14, wherein the predetermined delay is a half of the second period.

[c16] 16. The method according to claim 14, wherein the

fourth period is equal to the second period.

[c17] 17.The method according to claim 14, wherein:
the fourth oscillating signal is a pulse wave signal presenting a rising edge, a pulse width, and a falling edge during each period of the fourth period, and
the instantly transiting edge of the fourth oscillating signal refers to the rising edge thereof.

[c18] 18.The method according to claim 14, further comprising:
generating a first auxiliary signal by using the second oscillating signal and the fourth oscillating signal, in which the first auxiliary signal is a ramp wave signal presenting a rising portion and a falling edge such that the falling edge thereof simultaneously occurs with the instantly transiting edge of the second oscillating signal;
enhancing stability of the first auxiliary signal by using the fourth oscillating signal; and
inputting the first auxiliary signal to the second power supply channel.

[c19] 19.The method according to claim 14, further comprising:
generating a second auxiliary signal by using the second oscillating signal and the fourth oscillating signal, in which the second auxiliary signal is a ramp wave signal

presenting a rising portion and a falling edge such that the falling edge thereof simultaneously occurs with the instantly transiting edge of the fourth oscillating signal;
enhancing stability of the second auxiliary signal by using the second oscillating signal; and
inputting the second auxiliary signal to the fourth power supply channel.

[c20] 20.The method according to claim 19, further comprising:
performing slop compensation of current mode feedback control for the fourth power supply channel by using the second auxiliary signal after the step of inputting the second auxiliary signal to the fourth power supply channel.